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CARRY-OVER EFFECTS OF PCNB APPLIED TO THE SOIL FOR CONTROL OF POTATO SCAB[1]

G. V. C. Houghland and Lillian C. Cash[2]

Previous studies (1, 2, 4, 5, 6) have indicated the effectiveness of PCNB (pentachloronitrobenzene) when used as a soil fungicide for the control of potato scab (*Streptomyces scabies*). Houghland and Cash (4) found that PCNB when applied to the soil at 100, 150, and 200 pounds (active ingredient) per acre was more effective in reducing scab than P-162 (hexachlorocyclopentadiene), paraformaldehyde, sodium orthophenylphenate, or sulfur. However, they noted that vine growth was retarded for more than 44 days after planting when PCNB was applied at 200 pounds per acre. This effect became less pronounced as the season progressed, but at harvesting time the 200-pound rate had significantly reduced the total yield of potatoes.

The favorable results obtained with PCNB in reducing scab in the previous tests indicated a need for further work to determine (a) the carry-over fungicidal effects of PCNB for more than one season, and (b) the persistence of phytotoxic effects on succeeding potato crops. It was believed also that such tests would supply information to determine whether the initial cost of the fungicide could be offset, to some extent, through longer effectiveness.

For this work, the field at Beltsville, Maryland, previously used for scab control tests, was prepared by reinoculating in September 1954 according to the method of Houghland and Cash (3). At that time hydrated lime was applied at 1,000 pounds per acre to bring the soil reaction to approximately pH 6.0, and a rye cover crop was planted.

1955 Experiment

In the spring of 1955, PCNB[3] treatments were applied to the soil in the row mark and mixed. Katahdin potatoes were then planted by machine. The action of the furrow-opening and the bedding disks on the planter eventually placed the PCNB in the ridge over the potatoes and in the soil surrounding the seed pieces.

When the potato sprouts began to emerge, it was apparent that all the PCNB treatments had delayed sprout emergence to some extent. This effect was barely noticeable on the 100-pound treatment plots but was more pronounced as the rate was increased to 200 pounds. Delayed emergence on the 175-pound and 200-pound treated plots was followed by retarded plant growth which persisted almost until harvest.

The results of the 1955 experiment shown in table 1 (A) are in general agreement with those obtained previously (4). In column 4, table 1 (A), the yields of marketable potatoes from all the PCNB treatments show significant increases when compared with the untreated plots. Also,

[1]Accepted for publication January 7, 1957.

[2]Biochemist and formerly Assistant Pathologist, respectively, Horticultural Crops Research Branch, Agricultural Research Service, United States Department of Agriculture, Beltsville, Md.

[3]PCNB supplied by Olin Mathieson Corporation, Baltimore, Md.

the 100- and 150-pound treatments each produced more marketable potatoes than the 175- and 200-pound treatments. Nugent (5) and Fink (1) likewise reported that the effectiveness of PCNB tended to decrease with higher rates of application, but they suggested no satisfactory explanation.

In making comparisons of the marketable potato yields from treated and untreated plots in the present experiments, it should be borne in mind that the field was heavily infested with scab. Therefore, the untreated control plots produced potatoes that were more heavily scabbed, perhaps, than those that might ordinarily be found in a commercial field. Although this condition made the fungicide test more severe, it also tended to

TABLE 1.—*Effects of soil applications of PCNB for control of potato scab.*

(A) 1955 Experiment

PCNB—Lbs. per Acre (Active Ingredient)	Marketable Tubers per Acre			Scabby Tubers per Acre		Total Yield per Acre		Soil Reaction	
	Bus.	Per cent	(a) Diff. from CK	Bus.	Pct.	Bus.	(a) Diff. from CK	Planting pH	Harvest pH
100	231.2	89.5	+203.7(c)	27.0	10.5	258.2	+27.8(d)	6.4	6.0
150	220.7	89.0	+193.2(c)	27.2	11.0	247.9	+17.5(d)	6.3	5.8
175	174.4	95.9	+146.9(c)	7.4	4.1	181.8	—48.6(b)	6.6	5.7
200	185.0	92.1	+157.5(c)	15.9	7.9	200.9	—29.5(d)	6.5	6.1
None (CK)	27.5	11.9	....	202.9	88.1	230.4	....	6.7	6.4

(B) 1956 Experiment (No PCNB applied)

100	119.4	43.7	+ 45.8(c)	153.7	56.3	273.1	+13.6(d)	6.6	....
150	174.6	68.9	+101.0(c)	78.9	31.1	253.5	— 6.0(d)	6.2	....
175	101.2	46.2	+ 27.6(b)	117.8	53.8	219.0	—40.5(c)	6.8	....
200	182.3	70.8	+108.7(c)	75.3	29.2	257.6	— 1.9(d)	6.6	....
None (CK)	73.6	28.4	....	185.9	71.6	259.5	....	6.8	....

(a) = 6 Paired comparisons
(b) = Significant
(c) = Highly significant
(d) = Not significant

emphasize the effects of the treatments, since they were compared with the heavily infested checks. Soil naturally and uniformly infested would have been more desirable for the tests, perhaps, but such an infestation is rarely found.

The effects of PCNB on total yields were also similar to those previously reported (4). In table 1 (A), column 8, yield increases are reported for the 100- and 150-pound treatments which, although not significant, are similar to those reported by Nugent (5) using 50 to 174 pounds of PCNB. The reduction in total yield obtained in the present experiment from 175 pounds PCNB per acre undoubtedly was caused by the phytotoxic action of the fungicide at this rate. No explanation can be given why the 175-pound rate reduced the yield more than the 200-pound application.

1956 Experiment

To obtain information on the carry-over effects of PCNB in the soil and the persistence of phytotoxicity, the 1955 experiment was repeated in 1956, but without further treatment with PCNB.

After the 1955 crop was harvested, permanent stakes were set so the plots could be relocated in 1956. The land was disked in 1956 instead of being plowed in order to avoid transfer of soil as much as possible. Two-row plots were laid out exactly as they were in 1955, and Katahdin potatoes were planted with a 1-row planter adjusted to apply 1,800 pounds of 5-10-5 fertilizer per acre, in bands.

When the potato sprouts emerged, it was evident that the PCNB treatments applied the year before were noticeably delaying the rate of emergence. The effect was barely detectable on the 100- and 150-pound treated plots, but very noticeable on the 175-and 200 pound treated plots. Plant growth was retarded at the two higher rates of application for more than 50 days after planting.

The carry-over effects of the PCNB treatments on scab control and yields are shown in table 1 (B) and figure 1. It appears from table 1

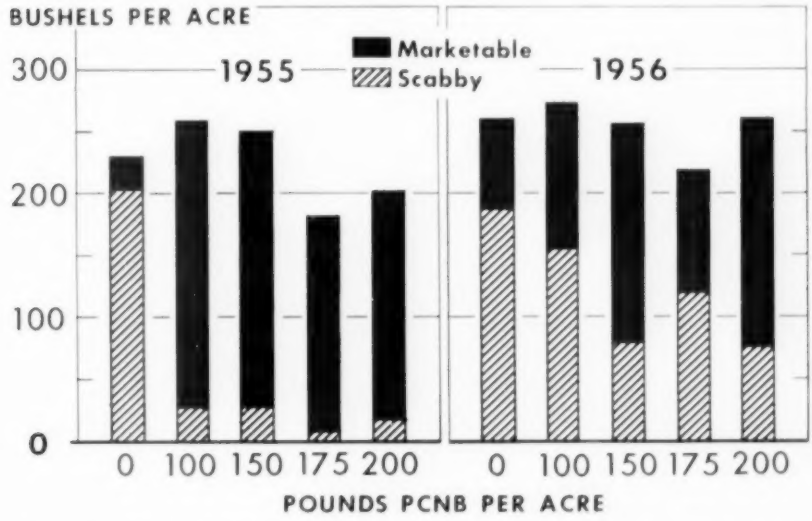

Figure 1.—Effects of PCNB on the growth of Katahdin potatoes and on scab control during the first and second seasons after application.

(B) that all PCNB treatments, the second year after application, increased the yields of marketable potatoes, when compared with the control plots. However, these results when compared with those for 1955 in table 1 (A) and figure 1, show that the amount and percentage of scabby potatoes in every case appreciably increased in 1956. These data, graphically presented in figure 1, indicate quite clearly that the fungicide had, after 1 year, lost much of its original effectiveness on scab.

The total yields of potatoes were, in general, less affected by the PCNB treatments in 1956 than in 1955, although phytotoxic effects were still evident. One exception was the 175-pound treatment which reduced the total yield significantly in 1956 as it did in 1955, producing more than a 40-bushel decrease each year.

Summary and Conclusions

The results of experiments conducted over a 3-year period, 2 of which are reported here and 1 elsewhere (4), indicate that PCNB is an effective soil fungicide for the control of potato scab. Its fungicidal effects were greater during the first season after application. When no further PCNB treatments were applied the following season, the percentage of scabby potatoes was multiplied 3 to 5 times, indicating a substantial loss of effectiveness.

From the standpoint of fungicidal effect and phytotoxicity it would seem that not more than 150 pounds per acre of PCNB should be applied in the row for scab control on potatoes. In these experiments, the lowest rate of application, 100 pounds per acre, was effective the first season, but after one year fungicidal action was appreciably reduced. Both Nugent (5) and Fink (1) have reported effective control of potato scab the first season with applications of 25 pounds PCNB per acre. At the present time, the cost of PCNB and its limited effectiveness restrict its use to low rates of application.

Potato growers confronted with a scab problem caused by soil infestation can use one or more of several remedial measures all of which have proved helpful under different circumstances. A scab-resistant potato variety can be grown, such as Menominee, Ontario, or Cherokee; sulfur can be used or an acid-forming fertilizer; PCNB (Terraclor) can be applied; or, as a last resort, where the infestation is extremely severe, another crop can be grown. In fields that are only lightly infested, PCNB or sulfur can be applied to the scab-infested areas as a precautionary measure to keep the organism from spreading. The fungicidal action of PCNB, however, will be much less effective the following season unless treatment is repeated.

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INTERACTION OF TEMPERATURE AND MOISTENING AGENTS IN THE GERMINATION AND EARLY DEVELOPMENT OF POTATO SEEDLINGS[1]

G. P. STEINBAUER[2]

Because of difficulties encountered in obtaining rapid and uniform germination of certain lots of potato seeds used in the potato breeding program at Michigan State University, the late Dr. J. Muncie suggested to the writer in 1952 that further experimentation on potato seed germination would be desirable. A review of the literature indicated that similar difficulties had appeared elsewhere and had led to several studies on the problem (3, 10, 11, 12). In brief, the experiments indicated that potato seed exhibits dormancy, which is most pronounced immediately after harvest, that the seeds are often highly temperature sensitive, that the dormant seeds do not respond to "prechill" treatments, nor to the application of such chemicals as ethyl alcohol, hydrogen peroxide, and ethylene. Stier (11) has suggested that seed dormancy is caused by restrictions of the enveloping layers of the seed rather than the embryo itself.

It occurred to the writer, that in view of the frequent use of nitrate solutions to break seed dormancy (1, 6), further attention might be given to its use in improving potato seed germination. The use of nitrate solutions has been effective to enhancing germination of seeds of many solanaceous plants such as cultivated and weedy plants of the genera *Capsicum*, *Lycopersicum*, *Physalis* and *Solanum* (1, 5, 6, 7, 8, 9). Furthermore Dunlap (4) has pointed out that when seedlings are grown in sand or similar substrates, rather than soil, as a means of reducing losses from "damping-off" organisms, many of them, including tomato, show marked improvement in early growth when nitrate solutions are used as the moistening agent. Clarke and Stevenson (3) mention the use of KNO_3 solution in germinating a lot of potato seed (S. 245-25 self pollinated) but did not observe significant increases in percentage or velocity of germination.

MATERIALS AND METHODS

Eight lots of potato seed were available for study[3]. Two of these, from Katahdin, and from mixed seedlings, were prepared from recently harvested seed balls, by pulping, washing and drying. Six lots were of known parentage, previously used in the potato breeding program at Michigan State University. These had been stored dry and varied in age from two to six years.

In the first experiments, limited to the recently harvested seed, four constant and one alternating temperatures were used with water, and 0.2

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[2]Associate Professor of Botany, Department of Botany and Plant Pathology, Michigan State University, East Lansing, Mich.

[3]Seeds and seed balls were supplied by Drs. J. Muncie, W. J. Hooker and E. Wheeler, all of Michigan State University, East Lansing, Mich.

per cent potassium nitrate (KNO_3) as moistening agents to determine the interaction of these two variables on germination. These first tests were started three weeks after the seeds were harvested. Other treatments included use of a one-week prechill at 5° C. prior to the temperature and moistening agent treatments, and also treatment of the seeds with 1 per cent thiourea and corrosion of the seed coats with concentrated sulfuric acid prior to germination.

Since the first experiments had indicated benefit from the use of nitrate solution, a second group was set up dealing with the response of seeds to water and nitrate solutions at 20°C. and 20°-30°C. In addition to the percentage and speed of germination, measurements were made of hypocotyl or stem lengths. Because of the labor involved, stem/root ratios were calculated only on seedlings of the Katahdin variety.

Experimental Results

The influence of temperatures and moistening agents on the germination of 3 week old seeds is shown in table 1. Seedlings of the nitrate solution series were noticeably larger than those of the water series even when the percentage germination was the same. Use of the one week prechill prior to the other treatments did not significantly increase germination percentage or speed. Addition of one per cent thiourea to the moistening agents did not enhance germination. Corrosion of the seed coats with sulfuric acid for periods ranging from 1 to 5 minutes, followed by thorough rinsing in water, prior to the germination treatments gave negative results. In all but the very shortest exposure to acid there was a marked increase in mold on the seeds, suggesting injury to the embryo.

Results of the second group of experiments are shown in tables 2 and 3. Since these were carried out six months after the first series, higher germinations were obtained for the Katahdin and mixed seedling groups than in the first experiments carried out shortly after harvest. These seeds had probably emerged from the highly dormant state by this time.

In a test dealing with interaction of temperature and nitrates on non-dormant seeds it was observed that equally good germinations were obtained at constant 20°C. and alternating 20°-30°C. Constant 15°C., constant 25°C. and constant 30°C. produced significantly lower percentages of germination. Although the percentages of germinations were the same there was greater speed of germination (time required for attainment of 50 per cent of the final germination) at 20° C. when nitrate was used as a moistening agent. Use of nitrate on the 20-30°C. series did not result in increased germination rate. Size of seedlings was significantly improved at both temperatures at 14 days when nitrate solution was used in place of water.

A limited number of tests using silica sand and also vermiculite gave results similar to those in which blotters were used. There was no advantage in the use of nitrate solution as a moistening agent in the soil tests.

Discussion

From the above results it becomes evident that although dormancy is very common in recently harvested potato seed there may be wide

TABLE 1.—*Germination of recently harvested seeds of potato as influenced by temperature and moistening agents.*

Temperature	Percentage Germination at 14 Days[1]			
	Katahdin Seeds		Seeds of Mixed Origin	
	Water	KNO_3 (0.2 per cent)	Water	KNO_3 (0.2 per cent)
15° C.	0	0	30	30
20° C.	32	56	66	68
25° C.	0	0	0	0
30° C.	0	0	0	0
20-30° C.[2]	8	20	62	60

[1]Based on 2 x 100 seeds on top of two thicknesses of blotter in petri dishes.
[2]Sixteen hours at the lower temperature and eight hours at the higher temperature daily.

TABLE 2.—*Seed germination and stem growth of potato seedlings to 14 days in relation to type of moistening agent.*

Origin of Seed	Percentage[1] Germination		Stem (hypocotyl) Length in Mm.[2]		
	Water	Potassium Nitrate	Water	Potassium Nitrate	Per cent Increase with KNO_3
Katahdin, 1953	87	92	14.2	24.2	70
BP 290-7 x BP 254-2, 1952	89	91	12.5	19.8	58
BP 229 x BP 179-1, 1952	94	93	12.4	17.6	42
BP 190-3 x BP 218-4, 1952	95	92	12.8	19.8	55
BP 256-7 x BP 191-10, 1952	92	92	15.4	27.9	81
245-252 x Menon self, 1948	83	93	13.1	20.7	58
Mixed seedlings, 1953	85	90	14.3	29.0	103
BP 256-7 x BP 218-4, 1952	76	85	13.3	22.4	67

[1]Based on 3 x 100 seeds on blotters in petri dishes at 20°C.
[2]Based on 75 measurements (3 x 25) for each treatment.

TABLE 3.—*Effect of different concentrations of KNO_3 on the percentage germination and stem/root ratio of seedlings of 6 months old seed from Katahdin potatoes.*

Moistening Agent	Percentage Germination[1]	Stem Length Mm.[2]	Root Length Mm.[2]	Stem/root Ratio
Water	76	13.6	17.0	.80
.1 per cent KNO_3	87	23.7	14.8	1.60
.2 per cent KNO_3	90	26.5	16.2	1.64
.5 per cent KNO_3	85	23.7	13.7	1.73
1 per cent KNO_3	76	11.6	9.6	1.21

[1]Based on 2 x 100 seeds on blotters in petri dishes at 20°C. Readings at 14 days.
[2]Based on 50 measurements at each treatment.

differences in the degree of dormancy. Thus, while the optimum temperature for the Katahdin seed was 20°C. equally good germination was obtained for a second lot of seed using constant 20°C., and alternating 20°-30°C. However all lots gave as good or better germination at 20°C. than other temperatures or temperature combinations. This finding is in agreement with those of Stier (10) who also found 20°C. superior to other temperatures. In the non-dormant seed 20°C. and 20°-30°C. were equally effective temperatures for germination. Neither the thiourea treatments nor use of concentrated sulfuric acid improved the germination of the dormant seeds.

The response of the potato seeds to potassium nitrate as a moistening agent, varied. It increased the percentage of germination in one of the two lots of dormant seed and increased stem elongation in both. In only two of the eight lots of non-dormant seed did nitrate solution increase the total germination. It increased the germination rate at 20°C. but not 20-30°C. However, in both dormant and non-dormant seeds there was a marked increase in size of seedlings when nitrate was used in place of water. Stem elongation in particular was increased. This led to a greater stem/root ratio. Such increases in stem/root ratio are suggestive of a need for exogenous supply of nitrogen for maximum early development, such as observed by Bosemark (2) in his studies of influence of nitrogen on root growth. These results point to the advantage of using nitrate solution in place of water as a moistening agent when potato seeds are germinated in blotters, sand or vermiculite in the laboratory, or when germinated in the greenhouse in media other than soil. As indicated in table 3, the optimum range of concentration of potassium nitrate for seed germination is between 0.1 per cent and 0.5 per cent.

Summary

Germination studies on eight lots of potato seed of various ages and origins substantiated the findings of other workers that for recently harvested seed a temperature near 20°C. is preferred over either higher or lower temperatures for germination. Some lots of recently harvested seed may also germinate at 20°-30°C.

For non-dormant seed either constant 20°C., or daily alternation of 20°C. to 30°C were equally effective in the attainment of maximum germination.

Substitution of potassium nitrate solution in place of water as a moistening agent increased the percentage germination in one of the two lots of dormant seed but not the other. Nitrate solutions also increased the velocity of germinations for all lots of non-dormant seed at 20°C. but not at 20°-30°C.

The use of nitrate solution increased the size and stem/root ratio of all lots studied at all temperatures. Optimum concentration of the potassium nitrate solution is 0.1 to 0.5 per cent.

On the basis of the above experiments it appears likely that increase in size, and, in some instances, rate of germination, will occur when potassium nitrate solutions are used for seed germination tests in the laboratory and for growing seedlings in the greenhouse in media such

as sand or vermiculite. The use of the nitrate solution should be limited to the initial moistening of the substrate. Replacement of water lost by evaporation should be with tap or distilled water to prevent excessive accumulation of nitrates.

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EFFECT OF TEMPERATURE ON BACTERIAL INOCULUM FROM RING-ROT-INFECTED TUBERS AS SHOWN BY STAINING TESTS AND BY INOCULATION STUDIES[1]

G. H. STARR[2] AND L. R. FINA[3]

During the years that research was being conducted by the senior author with ring rot of potatoes, particularly on the use of inoculum, the question was often pondered, "What is the effect of temperature and of other factors on the viability of the bacteria when used as a suspension"? Finally, it was decided to test the factor of temperature, at least rather extreme temperatures and the possible effect on the viability of these bacteria.

EXPERIMENTAL PROCEDURES

A suspension of ring-rot bacteria was made by using 7.5 grams of bacterial ooze squeezed from infected tubers to 250 c.c. of distilled water, mixed thoroughly by means of an electric stirrer. This suspension was then divided and to each was added an equal volume of distilled water. One solution was held at a temperature of 38°F. while the other solution was held at a temperature of approximately 83°F. Both were used in a series of inoculation tests. The tubers to be inoculated in these tests were cut into halves. One-half of each tuber was used for the 38° F. test whereas the other half was used for the 83°F. test. Ten such tubers were cut into halves for each test made. These were placed in a 10-inch moist chamber vessel containing the inoculum. The two tests were run simultaneously at the temperatures indicated. Each series of 10 seed-pieces was left in the ring-rot suspension for a period of 60 minutes. Immediately after the seed-pieces were removed, the suspension was well mixed and samples were placed on each of two slides, three drops to a slide. Such a test was made after each lot of seed-pieces was removed from the inoculum. Then several series of tubers were treated, one after another, until 10 lots had been inoculated. After this, the tests were intermittent being made after the suspension had stood for 25, 30 and 48 hours.

After the inoculations were completed, the seed-pieces were planted at the Agronomy Farm, Laramie. All seed-pieces were spaced 18 inches apart in the rows which were 36 inches apart. The plants were inspected several times during the summer for ring-rot symptoms and final readings were made on September 7. Each plant was carefully inspected for ring-rot symptoms which, if present, were evaluated as to degree of infection. For this purpose a scale of 0 to 5 was used (0 = no ring rot, 5 = leaves completely browned by infection).

The slides with the representative samples of the suspensions were heated, stained and examined for relative amounts of gram-positive and

[1]Accepted for publication December 17, 1956.

[2]Formerly Plant Pathologist and now Director of Agricultural Extension Service, University of Wyoming, Laramie, Wyo.

[3]Formerly in Department of Bacteriology and Veterinary Science, University of Wyoming, and now in Department of Bacteriology, Kansas State College, Manhattan, Kan.

gram-negative bacteria .The readings are shown, together with the accompanying percentage and severity of ring-rot symptoms for the various lots inoculated.

Temperature of Suspension in Fahrenheit	Lot Number[1]	Bacteria in Inoculating Suspension[2]		Ring-rot Symptoms	
		Gram +	Gram —	Per cent[3]	Severity[4]
38	1	2.5	1.0	100	3.4
83	1	2.5	0.1	89	3.6
38	2	2.5	1.0	100	3.9
83	2	4.0	1.5	89	3.4
38	3	2.0	1.5	80	2.8
83	3	1.5	1.0	75	2.5
38	4	2.0	1.0	100	2.9
83	4	1.5	1.0	100	1.9
38	5	2.0	1.0	100	2.5
83	5	0.5	1.0	60	1.7
38	6	2.0	1.0	100	2.9
83	6	1.0	1.5	89	2.3
38	7	1.5	1.5	89	1.7
83	7	0.5	3.0	70	1.4
38	8	1.0	1.5	67	1.8
83	8	1.0	2.5	70	2.2
38	9	1.0	0.5	80	2.4
83	9	0.5	3.0	80	1.8
38	10	0.7	0.9	83	1.7
83	10	0.3	1.0	80	2.2
38	25	1.5	1.0	75	1.4
83	25	0.0	8.0	0	0.0
38	30	0.4	1.0	90	1.8
83	30	0.1	7.0	0	0.0
38	48	0.1	0.5	90	1.8
83	48	0.2	7.5	0	0.0

[1]Also number of hours that suspension stood before it was used to inoculate tubers.
[2]Arbitrary figures used to show the relative number of bacteria present on slides.
[3]Percentage of plants showing infection.
[4]Average severity of ring-rot symptoms where maximum infection = 5.0.

Summary and Conclusions

Although the results are somewhat erratic, they do show that bacterial suspensions were greatly affected by temperature. When kept at a low temperature (38°F.), the suspension could be used for 48 hours, or possibly more, without greatly affecting the viability of ring-rot bacteria as shown by the percentages of infection obtained in the potato plants. However, the severity of symptoms was reduced somewhat in the delayed treatments. On the other hand when the inoculum was kept under warm

conditions, (83°F.) it deteriorated rapidly after 10 hours and produced no ring-rot symptoms at all in the potato plants.

In the stained slides, there was a tendency in both temperature series to find relatively less gram-positive bacteria, (ring-rot type) with continued use of the suspension. The gram-negative bacteria (soft-rot type) varied but little in abundance under cool conditions but did increase enormously in the suspension when used 25 hours or more.

NEWS AND REVIEWS

POTATO INDUSTRY IN TURKEY[1]

KAMIL ILISULU[2]

The potato was introduced from Russia and the Caucasus into the eastern part of Turkey about 85 years ago and into the western part from Europe about 50 years ago. Production of the crop increased rapidly during the last 50 years in the neighborhood of Adapazare. This now is a famous early potato production area. Commercial production has developed extensively in two places—one in the northeast, the other in the northwest part of Turkey. However, the crop is being grown and used as food by the people in all parts of the country.

Acreage and yields are increasing from year to year so that the crop constitutes an important part of the total income of Turkey. According to the general directory of statistics of June 1953, the income from potatoes was 85,601,000 Turkish liras or $30, 575,000.[3]

In the 20 years from 1933 to 1952 the area used for the crop increased from 35.502 hectars* (84,755 acres) producing 106,809 tons (234,047,890 pounds or 3,887,666 bushels(to 110,103 hectars (250,256 acres) producing 870,000 tons (32,045,000 bushels). This was approximately an increase of three fold in area and eight fold in production per acre, indicating a great improvement in production practices during these 20 years. The total area grown, the total production and the yield per acre (or per dekar) are reported in table 1.

POTATO PRODUCTION AREAS

Some potatoes are grown in all of the provinces in amounts ranging from 9 acres in Hakkari (extreme southeast) to 2936 acres in Kastamonu (northcentral). (For location of provinces see map in figure 1.) The major producing provinces grouped by areas and some of the characteristics of each of these areas are the following:

Northeastern: Mostly high dryland area with cool summers that are favorable for growing seed potatoes. The most important provinces here are Trabzon, Ordu, Erzurum, Coruh and Kars. (Table 2).

Central: The most extensive area, where irrigation is necessary because of low rainfall, the provinces of greatest production are: Konya, Kayseri, Kutahya, Yozgat, Nigde (chiefly Bors County) and Sivas.

Northwest: Famous because of very high yields per acre: Cankiri, Kastamonu and Zonguldak.

*One hectar = 2.47 acres. One acre = 0.046 dekar or 1000 M² One metric ton (1000 kgs.) = 2184 lbs. or 36.4 Bus. (60 lbs. per bus.)

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[2]Department of Plant Industry, College of Agriculture, University of Ankara, Turkey. Prepared when in residence at the University of Nebraska, October 1955 to October 1956 as a participant in the University of Nebraska International Cooperation Administration Program for educational services to Turkey. The author wishes to acknowledge extensive cooperation of H. O. Werner in the preparation of the English version of this paper.

[3]In 1956 the official exchange rate of Turkish lira to U.S. dollars was 2.8 to 1.

TABLE 1.—*Potato production in Turkey 1947-1953.*

Year	Production		Area		Yield per	
	M. Tons	(Bushels)	Hectars	(Acres)	Dekar (Kgs.)	Acre (Bushels)
1947	325,410	(11,954,560)	62,467	(149,300)	520.9	(75.8)
1948	454,356	(16,540,160)	65,764	(162,600)	690.8	(100.6)
1949	414,509	(13,891,440)	67,241	(166,100)	616.4	(89.7)
1950	605,220	(22,030,280)	75,492	(186,500)	802.2	(117.9)
1951	675,921	(24,600,960)	85,538	(211,200)	790.2	(115.8)
1952	870,000	(32,045,000)	110,103	(250,300)	790.2	(115.8)
1953	1,000,000	(36,400,000)	115,000	(253,000)	950.0	(134.3)
1954	1,000,000	(36,400,000)	109,000	(226,605)	912.0	(134.3)
1955	1,116,000	(40,626,100)	109,000	(226,605)	1023.8	(150.0)

FIGURE 1.—Production of potatoes and acreage in the various provinces of Turkey as well as designation of the principal seed potato growing areas.

Sea of Marmara area: Includes Kocaeli, Adapazari (very important early crop area) and Bursa in which is Inegol County where rich flat land is very productive. Some seed potatoes are grown here.

West: Izmir, where Odemis County is most important.

South: Antalya and Adana provinces and valleys in other provinces of this general area. Here spring occurs earlier than elsewhere, summers are hot, winters very mild. Early maturing varieties are grown for the early markets.

CLIMATE

The climate and soils in more than 90 per cent of the country is suitable for potato production but there is great variation in rainfall, temperature, wind, cloudness and light intensity in different parts of the country. At Ankara in the central Anatolian plateau, winters are cold and hot summers are dry as in the central western plains area of the United States. The Adana vicinity in south Turkey has a climate similar to Florida

TABLE 2.—*Potato production in the leading provinces grouped by general geographic regions. (Sixteen-year averages 1937-1952)*

Area and Provinces	Area		Production		Unit Yields	
	Hectars	Acres	Metric Tons	Bushels	Per Dekar, Kgs.	Per Acre, Bushels
Northeastern:						
Trabzon	3,283	8,109	21,251	773,530	653	95
Ordu	2,751	6,794	16,538	601,980	601	89
Erzurum	3,500	8,645	8,857	323,394	743	110
Kars	1,734	4,283	9,813	357,226	565	83
Coruh	1,006	2,285	3,967	144,412	394	58
Central:						
Konya	3,853	9,516	37,051	1,347,656	963	142
Kayseri	3,453	8,528	20,384	741,978	590	87
Kutahya	2,749	6,790	19,718	717,733	717	106
Yozgat	2,256	5,572	14,318	521,171	634	93
Nigde	4,003	9,887	13,434	488,997	761	49
Sivas	1,526	3,769	13,510	491,809	885	131
North Central:						
Cankiri	3,186	7,869	21,285	774,775	668	98
Kastamonu	1,189	2,936	8,857	323,394	744	110
Zonguldak	2,059	5,086	13,875	505,096	679	99
West:						
Izmir	1,820	4,496	11,108	404,368	610	90
South:						
Antalya	1,265	3,125	5,546	201,892	438	64
Adana	754	1,862	2,837	103,276	376	55
Sea of Marmara:						
Bursa	2,845	7,027	16,011	582,800	562	83
Kocaeli	2,248	5,552	11,867	431,957	527	78

and some of the other southern states of the United States. The climatic characteristics of two widely differing areas, Ankara and Adapazari are shown in table 3.

About 60 per cent of the crop is raised in home and commercial vegetable gardens, 20 per cent on large exclusive potato farms and 20 per cent on other types of farms The large specialized farms are in the extensive commercial production areas or near the large towns such as Adapazari and neighboring areas close to Istanbul which being a large city is a good market. Large farms also occur in Izmir province where a good market exists in the large city of Izmir.

On these large specialized farms—where yields are high— potatoes are grown in rotation with small grain, corn or tobacco.

A very interesting method used in small vegetable gardens where land is very expensive is the "pit" or "mine shaft" method as shown in figure 2. With this method the seed potatoes planted at the bottom of a pit 2 to 4 feet deep and 12 to 18 inches wide are covered with rich soil (50 per cent soil, 50 per cent animal manure). As the plants grow, loose soil is filled in layer by layer until the pit is full. Yields are 12 to 16 lbs. per plant.

TABLE 3.—*Climatic characteristics of two widely differing areas. (Averages for 25 years—1926-1950.)*

Time	Precipitation	Temperature	Relative Humidity Per cent	Wind-Velocity and Direction	Amount of Sunshine Hours per Day
	Mm. (in.)	°C (°F)		M/sec (m.p.h.)	
Ankara					
Annual	340.7 (14)	11.7 (53.0)	60	2.4 (19.3) NE	
Apr.-Sept.	143.4 (5.6)	18.5 (67.0)	48	2.5 (20.1) NE	1874.4*
April	31.3 (1.2)	11.2 (52.7)	57	2.8 (22.5) NE	7.7
May	48.5 (1.9)	16.3 (61.0)	56	2.3 (18.5) NE	8.9
June	25.7 (1.0)	20.1 (68.0)	50	2.3 (18.5) NE	11.3
July	12.5 (0.5)	23.2 (73.8)	42	2.7 (21.7) NE	12.6
Aug.	10.1 (0.4)	23.3 (73.9)	41	2.7 (21.7) NE	10.7
Sept.	15.3 (0.6)	18.5 (67.0)	46	2.3 (18.5) NE	7.8
Adapazari					
Annual	791 (31.6)	14.2 (57.0)	72	1.4 (11.2) SE	
Apr.-Sept.	303.8 (12.1)	19.2 (67.0)	69	1.4 (11.2) SE	1659.4*
April	49.0 (1.9)	12.2 (54.0)	70	1.6 (12.8) SE	6.6
May	45.0 (1.8)	17.3 (64.0)	70	1.6 (12.8) SE	8.1
June	47.1 (1.8)	21.0 (69.0)	67	1.6 (12.8) SE	10.6
July	55.6 (2.2)	23.2 (73.8)	67	1.5 (12.0) SE	12.6
Aug.	34.1 (1.3)	23.2 (73.8)	67	1.4 (11.2) SE	10.7
Sept.	73.0 (2.9)	19.2 (67.0)	72	1.2 (0.9) SE	7.8

*Total sunshine hours for April through September.

Alluvial soils—very good for growing potatoes— occur in flood plains along rivers or in river deltas in the provinces of Adapazari, Duzce, Hendek (northwest), Odemis (west), Antalya and Cukurova (south, early crop). Because of the high temperatures and high humidity in these areas, diseases and insects increase more rapidly than elsewhere. In many small areas throughout the country where climatic conditions are favorable for potatoes some soils are suitable for the crop. Some of these areas are on the plateaus or mountains and most but not all of them require irrigation. Thus potato growing areas are scattered throughout the country like islands. In these scattered areas potatoes are grown chiefly by the village people on their small family farms.

Potato growers generally recognize that it is necessary to prepare a good seed bed for potatoes. With irrigation farming, the first and deepest plowing (7 to 10 inches) is in the fall after small grain, alfalfa, corn, beets or tobacco. With dryland culture plowing is not so deep, partly to avoid depending on the weather and previous cropping. This land is again plowed losing soil moisture. Fall plowing is done any time during the fall, once or twice in the spring, but then not so deeply.

In some regions with sufficient rainfall during the growing season the water table is only 3 to 5 feet below the surface.

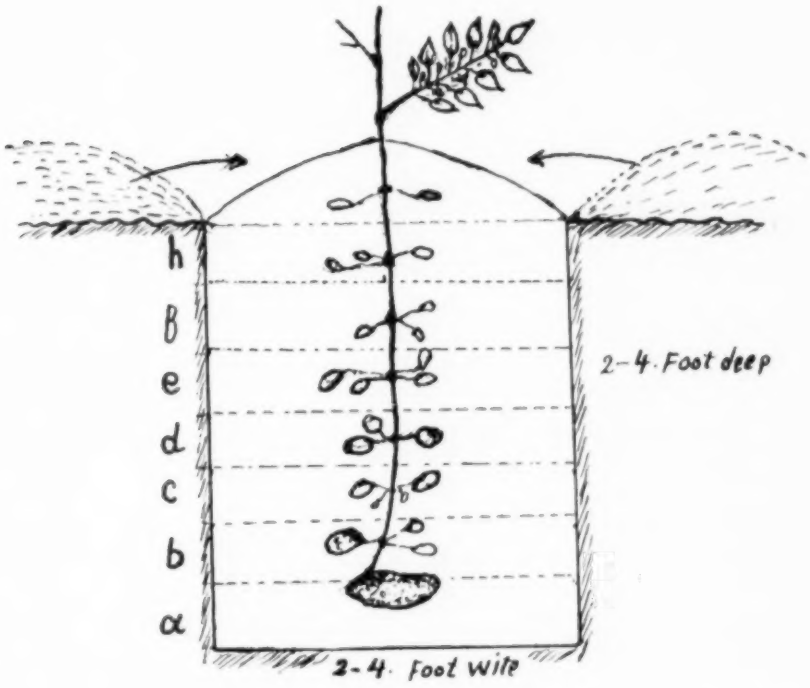

FIGURE 2.—Pit or mine shaft method of potato production used in some small vegetable gardens.

FERTILIZATION

Animal manures are preferred because af the better soil physical conditions they bring about. Most farmers are assured sufficient manure for potatoes because of the millions of sheep, goats, cattle and horses that are being raised. The amount used is usually about 8 tons per acre, ordinarily applied in the fall.

Many growers, especially in irrigated areas, use commercial fertilizers. The amounts of the various types usually used are:

Treble superphosphate (40-45 per cent P_2O_5)	70-120	lbs.	per	acre
Superphosphate (16-18 per cent P_2O_5)	140-250	"	"	"
Ammonium sulfate (25 per cent ammonia)	40-100	"	"	"
Ammonium nitrate (30 per cent NO^5)	30-50	"	"	"
Potassium sulfate* (16 per cent K_2O)	20-80	"	"	"

(*Seldom used as most soils have sufficient K.)

Some farmers use both animal and commercial fertilizers. Commercial fertilizers are usually applied to the soil in the furrows opened for planting. Some growers plow under green manures such as alfalfa, broad beans, *etc.*

Crop Rotation

In all potato producing areas there is usually an interval of two to four years between potato crops. Crop rotations stabilize the potato acreage and distribute the risks and labor among other farm enterprises. On irrigated land, rotations including alfalfa and sweet clover are best. Some desirable rotations are:

No.	*First Year*	*Second Year*	*Third Year*	*Fourth Year*	*Fifth Year*	*Sixth Year*
1.	Potatoes	Cereals	Beets	Tobacco	Potatoes	....
2.	Potatoes	Corn	Alfalfa	Alfalfa	Alfalfa	Alfalfa
3.	Potatoes	Beans	Cereals	Tomatoes	Sweet clover	....
4.	Potatoes	Broad beans	Vegetables	Cereals	Potatoes	....

On dry land, cereals and watermelons are commonly the other crops in the rotation.

The planting seasons in the various parts of the country occur during the four months as follows:

In the south—especially Adana and Mersin provinces—in early March;
In the west—middle or late March;
Bordering the Black Sea—late March or early April;
Interior portion—middle or late April;
Eastern part—early or mid June;
Mountain areas—late June or early July.

Tubers weighing 70 to 80 grams are usually planted. Cut seed is seldom used. Planting is usually done by hand into furrows opened with a tractor or horse. Potato planting machines are seldom used, as they are too expensive for the family farmers. Spacing in irrigated fields is usually 16 inches in rows 34-35 inches apart. On dryland the spacing is 20 by 40 inches.

Seed Production

There is no seed potato certification program in Turkey, but one should be developed soon. In some of the high lands conditions are very suitable for growing good seed potatoes. The best seed potato producing areas are the following (See figure 2).

Northeast: Highest portions in Trabzon and Kars.
Central: Nigde (Bor County—usually a cool area).
Northwest: Kastamonu and Bolu (many small high altitude areas).
West: Odemis (some villages on mountains near the Aegean Sea have a cool climate, also at some places on the Uludag Mountains in Bursa Province. Some seed potato research is being conducted here by the Regional Agricultural High School and the Regional Agricultural Office.

Unfortunately there is now no statistical information about the amount of specialized seed potato production in Turkey. The widespread occurrence of fusaria and virus diseases and the unsatisfactory storages create serious problems for seed potato producers.

Varieties

The University of Ankara has tested 61 varieties. The characteristics of the six varieties that appear best, or are grown most are as follows:

Variety or Number	Tuber			Per cent of Fresh Weight			Yield Bu./A.	Provinces Where Grown
	Shape	Color		Starch	Protein	Ash		
		Skin	Interior					
Sarikiz	R,O	W	Y	11.9	2.4	1.3	63.5-102-3	Adapazari to Izmit
Trabzon patatesi	R,O	LBr	Y	14.2	2.2	1.1	67.5-76.8	Duzce to Trabzon
Malta patatesi	O	...	W	21.3[1]	1.4	1.1	46	Kayseri Nigde,
Red potato (6-176)	R,O	Re	LY	18.1[1]	1.8	1.1	74	Nigde, Bingol, Maras
Red potato (8-224)[2]	R	Re	W	19.5[1]	1.6	1.1	120-138	Ankara, Rize, Coruh
102[1]	R,O	DBr	DY	14.8	2.1	1.1	114	Odemis (Izmir)

Shape: R = Round, O = Oval; Color—Skin: W = White, Br. = Brown, Re = Red
Interior: Y = Yellow (L = Light, D = Dark), W = White.
All are grown primarily for table use, but those marked[1] are most useful for starch extraction. The first two are earlier than the other varieties.
[1]Very useful for starch manufacture.
[2]Sometimes called "white potato" because interior is white.

Irrigation

Most potato production is with irrigation with water from rivers, springs and lakes or from dams, irrigation canels or pumping systems. The provinces where irrigation is seldom used because rainfall is adequate are: Duzce, Hendek, Adaparazi and some parts of Bursa, Inegol, Bolu in the northwest and some parts of Izmir in the west and Zonguldak, Kastamonu, Samsun and Ordu in the north. Usually 3 to 4 or even 6 irrigations are used per season. With light soils the interval between irrigation is usually 12-14 days, and with heavy soils 18-20 days.

Much of the harvesting is with hand hoes, spades, or plows pulled by tractors or horses especially in mountainous fields. With hand digging there is little harvest time damage to the tubers. Data typical of the range of yields with and without irrigation are reported in table 4.

Potatoes are transported in sacks by railroad trucks or horse-drawn wagons. All potatoes are sold within the country, none are exported. The early crop is sold in Ankara and Istanbul for 120 kurus per kilogram (120 kurus = $.40)* or $9.00 to $10.00 per bushel. The late or fall crop is usually sold in the field before the crop is harvested for a flat price for the field. During the long summer harvesting period prices are usually between 15 and 20 kurus per kilogram or approximately $1.35 to $1.80 per bushel.

*100 Kurus = 1 lira

TABLE 4.—*Range of yields per acre in two provinces.*

Province	Relative Yield	Variety	1951 Kgs. (Bus.)	1952 Kgs. (Bus.)	1953 Kgs. (Bus.)
Ankara (irrigated)	High	Kemaliye	13,668 (492)	12,840 (462)	12,400 (466)
	Low	Kirklareli	3,260 (117)	2,848 (102)	2,460 (88)
Adapazari (Rainfall only)	High	Rize	12,592 (453)		
	High	Kemaliye		7,820 (287)	7,608 (273)
	Low	Kirklareli	3,236 (116)	2,804 (101)	2,804 (101)

At harvest time the sound potatoes are stored in ground-covered pits, cellars or large storages. Small quantities are usually stored in pits and covered with dirt and straw. They are held here either until they are sold or until early spring. Much loss occurs in pits because of the difficulty of providing proper temperature and humidity.

Cellars are preferred because of their greater convenience and efficiency. Sometimes storages are in farmers houses but other times they are separate structures in the fields. They can be made to maintain a temperature of 3° to 6° C during the winter with 70 to 90 per cent relative humidity. As yet there are very few large storages with temperature and humidity control in Turkey.

UTILIZATION

Approximately 90 per cent of the crop was used for human food; 5 for starch and 5 per cent for animals. As human food, the potatoes are boiled, mashed, french fried, made into chips, used in salads, and also in various Turkish dishes. Some are converted into starch either in commercial factories or on the farms for home use. The starch is used to manufacture alcohol, powdered sugar, baby food, adhesives, *etc*. The large factories are located in the commercial potato and corn areas in Istanbul, Izmir, Adapazari, Adana and Samsun provinces. Small hand operated starch extraction facilities are scattered throughout the country to procure starch for use in Turkish foods.

RESEARCH

As yet little scientific work has been done in Turkey with the potato crop. Many bulletins and articles have been published about growing methods, seed improvement, varieties, marketing and storage. Many horticulturists with the schools or Ministry of Agriculture have been conducting practical tests and demonstrations for the purpose of helping farmers improve their potato crop.

The Department of Horticulture of the Agricultural College of Ankara University has been working with the crop. Other agricultural colleges that will probably be giving attention to the crop are a new one in Izmir in western Turkey and the one in Attaturk University which is now being started in eastern Turkey .

The agricultural high schools (vocational senior high schools) are the Barnova School in Izmir, Halkali in Istanbul, Cekirge-Bursa in Bursa and Adana in Adana. They have experimental work and do teaching with potatoes.

There are some vocational agricultural schools called Koy Enstitusa (or now Ogretmenokulu or teachers' schools). They have been teaching students practical production methods with potatoes and other crops. They have fields and gardens for demonstration or instruction in production practices, but as yet they have not been testing potatoes. After five years in these schools the students will be teachers in village schools.

Some funds for research are provided to the University of Ankara by the Minister of Agriculture. One such project conducted recently by the author was the testing of Turkish and foreign varieties at five places which differ widely in soil and climate, Ankara, Adapazari, Eskisehir, Erzurum and Ordu. No greenhouses for research are now available, but one is soon to be built at Ankara University.

Current research and development efforts are concerned with the search for better varieties; work toward developing varieties adapted to both high mountain regions and low altitude areas, elimination of virus diseases in seed stocks, development of a seed certification program and studies with storage.

MINUTES OF ANNUAL BUSINESS MEETING OF THE POTATO ASSOCIATION OF AMERICA

Netherlands-Hilton Hotel

December 7, 1956

President C. W. Frutchey called the meeting to order at 1:30 P.M.

It was moved by R. H. Larson that the minutes of 1955 Annual Meeting of the Potato Association of America, September 7, at East Lansing, Michigan, be accepted as published. Seconded by O. C. Turnquist. Motion carried.

Minutes of the Executive Committee Meeting, December 5, 1956, at Cincinnati, Ohio, were read by W. J. Hooker. Paul Eastman moved that the minutes be accepted. Seconded by R. H. Larson. Motion carried.

Factors to be considered in the selection of the next meeting place were discussed. Paul Eastman moved that ballots be mailed to all regular members in the United States and Canada to determine the place of meeting in 1957. Seconded by R. E. Webb. Motion carried 22-6.

The following locations are under consideration: Meeting in Toronto and Ottawa, Canada in November; meeting with the AIBS at Stanford University and National Potato Utilization Conference, Albany, California in September; meeting at USDA, Plant Industry Station, Beltsville, Maryland in December.

Report of the Policy Committee was presented by Chairman N. M. Parks. Report accepted.

Report of the Potato Handbook Committee was presented by Chairman, R. W. Hougas. Advertising charges in 1956 were $125.00 for a one-page advertisement, $65.00 for a half-page ad, $40.00 for a quarter-page ad and $10.00 for a firm name listing in the buyers guide. The advertising manager and associate editor is Mr. Clifford Hutchinson, 4121

Mineral Point Road, Madison, Wisconsin. Cost of the Handbook to buyers is: single copy, $2.00; 5 to 10 copies, $1.00; 11 to 50 copies, $.50; over 50 copies, $.25. A motion, that the report of the 1956 Handbook Committee be accepted was made by R. W. Hougas, seconded by J. C. Campbell. Motion carried.

Report of the treasurer was presented by John Campbell. He reported a balance of $5,277.47 at the end of fiscal year, July 31, 1956. Report accepted. Written reports of the meetings of the Technical Committees on December 6 were presented. Virus Committee, W. G. Hoyman; Certification Committee, J. W. Scannell; Potato Introduction Committee, R. V. Akeley; Late Blight Committee, M. E. Gallegley; Ring Rot Committee, Paul Eastman. Reports accepted.

A motion was made by J. W. Scannell, Chairman of the Certification Committee to accept the Ring Rot Committee Report and requested that Karl Fernow's paper on the Zero Tolerance for Ring Rot be published in the American Potato Journal. Motion seconded by Paul Eastman and carried.

Report of the Membership Committee was presented by O. C. Turnquist. Report accepted.

Report of the Auditing Committee stating that they had examined the treasurer's books and found them correct and in good order was presented by Paul Eastman. Report accepted.

It was moved by N. M. Parks that the Potato Association publish a 1958 Potato Handbook. Seconded by Arthur Hawkins. Motion carried.

It was moved by Paul Eastman, that the Advertising Commission for ads in the Potato Handbook and Journal should return to 10 per cent at the beginning of the fiscal year, August 1. This rate is to be effective on the first $4,000.00 of advertising each fiscal year, increasing to 25 per cent on advertising in excess of $4,000.00. Seconded by Harry Moore. Motion carried.

It was moved by R. W. Hougas that the Treasurer's salary be increased to $720.00 a year and that the Editor's salaries be increased to $1,080.00 per year.

It was moved by Paul Eastman that Honorary Life Memberships in the Potato Association for the year 1957 be selected on the basis of one technical, one industrial, and one foreign member. Seconded by R. H. Larson. Motion carried.

It was moved by H. O. Werner that action of the Executive Committee be endorsed in pledging $25.00 to the development of a monument to the potato in the field where the crop is believed to have been first grown in North America. Payment of this is contingent upon other pledges of sufficient funds to complete the monument. Seconded by Paul Eastman. Motion carried.

It was moved by N. M. Parks that the theme of the 1958 issue of the Potato Handbook be "Potato Machinery & Equipment". Seconded by J. C. Campbell. Motion carried.

It was moved by J. C. Campbell that the Potato Association apply for affiliate membership in the AIBS, cost to be $100.00 per year. Seconded by G. H. Rieman. Motion carried.

It was moved by R. H. Larson that a question be inserted in the ballot for selecting the location for the next meeting as follows: Vote yes

or no whether members are interested in a meeting of an international character in 1959 near and at a time close to the meeting of the International Botanical Congress to be held in Canada. Seconded by G. H. Rieman. Motion carried.

Report of the Nominating Committee was made by Arthur Hawkins as follows: R. W. Hougas, *President*; N. M. Parks, *Vice-President*; E. J. Wheeler, *Director*. O. C. Turnquist moved that the report of the Nominating Committee be accepted and that a unanimous ballot be cast. Seconded by C. E. Cunningham. Motion carried.

The Executive Committee re-elected John Campbell, Treasurer for two years and W. J. Hooker, Secretary for one year, by mail ballot following the meeting.

Respectfully submitted.
W. J. Hooker, *Secretary*

1957 COMMITTEES

Potato Association of America

Officers and Executive Committee

R. W. Hougas, *President*	W. J. Hooker, *Secretary*
N. M. Parks, *Vice President*	O. C. Turnquist, *Director*
C. W. Frutchey, *Past-President*	W. G. Hoyman, *Director*
J. C. Campbell, *Treasurer*	E. J. Wheeler, *Director*

Standing Committees

Program Committee
W. J. Hooker, *Chmn.*, Officers of the Association

Nominating Committee
J. W. Scannell, *Chmn.*, G. H. Rieman, R. Bonde

Membership Committee
N. M. Parks, *Chmn.*, Officers and Executive Committee of the Association

Sub-Committee on Sustaining Memberships
Arthur Hawkins, *Chmn.*, J. C. Campbell, Cliff Hutchinson

Auditing Committee
O. C. Turnquist, E. J. Wheeler, W. G. Hoyman

Committee on Local Arrangements
W. J. Hooker, *Chmn.*, Others to be determined

Editorial Board
Ora Smith, J. C. Campbell, R. E. Webb, F. Ross

Special Committee

Handbook Committee
W. G. Hoyman, *Chmn.*, J. C. Campbell, Cliff Hutchinson, C. W. Frutchey, R. W. Hougas

Honorary Life Membership Committee
C. W. Frutchey, *Chmn.*, Executive Committee plus the ten immediate past presidents

POLICY COMMITTEE

R. V. Akeley, *Chmn.*, O. C. Turnquist, W. J. Hooker

POTATO CERTIFICATION COMMITTEE

P. J. Eastman, *Chmn.*, J. W. Scannell, C. W. Frutchey, H. M. Darling, K. H. Fernow

LATE BLIGHT INVESTIGATIONS

M. E. Gallegly, *Chmn.*, C. J. Eide, John Niederhauser, W. R. Mills, R. Bonde, J. L. Howatt, L. C. Peterson, R. E. Webb

VIRUS DISEASE INVESTIGATIONS COMMITTEE

R. E. Webb, *Chmn.*, R. H. Larson, S. B. Locke, W. J. Hooker, N. S. Wright, W. G. Hoyman

POTATO UTILIZATION COMMITTEE

Kris Bemis, *Chmn.*, R. H. Treadway, Robert Sawyer, W. W. Weber

INTERNATIONAL RELATIONS COMMITTEE

UNITED STATES

R. H. Larson, *Chmn.*, F. D. Cochran, D. S. Correll, Marx Koehnke, Ora Smith

CANADA

D. S. MacLachlan and L. C. Young

CENTRAL AND SOUTH AMERICA

E. H. Casseres, J. Cervantes, N. Estrada R., A. B. Montaldo, Carlos Ochoa, K. M. Silberschmidt, M. V. Fernandez Valiela

EUROPE

Maria-Luise Baerecke, George Cokerham, J. G. Hawkes, C. Martin, J. Munster, A. Rozendaal, H. J. Toxopeus

COMMITTEE ON ARRANGEMENTS FOR 1959 MEETING IN CANADA (in connection with the International Botanical Congress)

R. H. Larson, *Chmn.*, Ora Smith, L. C. Young, D. S. MacLachlan

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LATE BLIGHT INVESTIGATIONS

COMMITTEE REPORT—1956

M. E. GALLEGLY, *Chairman*, R. V. AKELEY, REINER BONDE, C. J. EIDE, J. L. HOWATT, J. S. NIEDERHAUSER, L. C. PETERSON, AND W. R. MILLS

The Late Blight Investigations Committee of the Potato Association of America has limited its thoughts and activities to the problem of breeding for resistance to late blight and to the matter of physiologic specialization by the pathogen. Although there has been no activity of the committee as a whole during the last year, the various members have exchanged information and ideas through personal conversations and correspondence.

In the past the committee helped clarify the complicated interrelationship of pathologic races and genes for resistance to these races and assisted in the adoption of an international nomenclature of these races and genes. Consideration was given to the establishment of a uniform set of differential hosts and the maintenance of pure cultures of the various races. In

addition, discussions were carried on with Plant Quarantine officials concerning the importation of selected races to use as tools in a program of breeding for resistance.

As a whole, the International Nomenclature System has been helpful and useful. The committee recognizes that future work may show the need for a revision or an entirely different system. Pure cultures of physiologic races have been maintained by individuals at different institutions. The maintenance of a uniform set of differential hosts has been more difficult. Clones tend to become contaminated with virus diseases and some produce low yields in certain areas. The Potato Introduction Station has assisted in maintaining clean hosts. The committee has been advocating the development of true-breeding lines of *S. demissum* as differential hosts so that true seed might be used to produce plants for race identification. Plant Quarantine officials have hesitated to allow new races to be imported. Their stand is justifiable when one considers the possible damage which might occur if certain of these races were allowed to escape.

As for the future in breeding for resistance, workers are turning more toward the polygenic type of resistance. The obvious reason for this trend is the occurrence of physiologic races capable of infecting and destroying, varieties with all of the known dominant genes. In the past, as the four dominant genes were discovered and introduced into commercial potato seedlings, new races were found in a short time. At present, workers have found other new dominant genes and indications are that seedlings with these new genes eventually will go out with new races. In fact, workers in Mexico reported that seedlings with at least one of these new dominant genes blighted there the first time they were grown in the field.

In contrast, the polygenic or so called field resistance appears to give resistance to all of the recognized physiologic races. Plants with this type of resistance are not immune and under severe blight conditions usually have lesions. Some workers have established clones with varying levels of the polygenic type of resistance. Whereas most selections have moderate to low levels of this resistance, some appear to have a very high degree of resistance. In fact, the level of polygenic resistance in some clones approaches the degree of resistance given by dominant genes to race O. The workers in Mexico, where all known races occur in nature, indicate that this type of resistance is the only type giving effective control there.

The dominant type of resistance has been derived from *Solanum demissum* whereas the polygenic type is found scattered among various seedlings of *S. tuberosum*. One cannot be sure of the original sources of this latter type even though it is known that certain *S. demissum* accessions carry both types. Many different terms such as "field resistance," "minor-gene resistance," "multiple-gene resistance" and "multi-genic resistance," have been used to denote the type of resistance referred to as "polygenic resistance" in this report. The Late Blight Investigations Committee has not made a decision as to which term would be most appropriate. Multiple-gene or multigenic, and polygenic resistance are considered synonymous by some breeders whereas others consider that these terms have slightly different meanings.

In addition to resistance work with *S. demissum* and derivatives, attention is being turned toward the resistance carried by other species such as *S. bulbocastanum*, *S. stoloniferum*, *S. pinnatisectum*, *etc.* Difficulty

has been encountered in obtaining successful crosses with some of them, but with special techniques, there is indication that this barrier may be broken. The Potato Introduction Station at Sturgeon Bay, Wisconsin has been supplying many of these species, and workers there have made some of the initial crosses. It is possible that other types of resistance may be carried by these species. As stated by committee member J. L. Howatt, "there are millions of questions which are begging answers in regard to the development of blight resistance through the utilization of wild species."

A great deal of work with physiologic specialization by the fungus is being done by various committee members and others. This has followed along the lines of race surveys in a given area and studies on the nature of race development. The race surveys have shown that most all of the races of the International series, including race 1,2,3,4, have been found in Canada, Mexico and the United States. In addition, isolates have been found in Canada and Mexico which are more highly specialized than race 1,2,3,4, (*i.e.* 1,2,3,4,5,).

Studies on the nature of race development have indicated that the fungus is unstable, particularly for the race 4 character, and that new races arise by mutation. Detailed studies at West Virginia have shown that race 4 will appear in almost any culture. For instance, in a culture of race 0, race 4 may be found; in a culture of race 1, race 1,4 may be found; in a culture of race 1,2 race 1,2,4 may be found, *etc.* Thus, the committee would like to point out that the R_4 gene is useless in a practical program of breeding for resistance. Race surveys in Canada, in Europe, in the United States and other areas have shown a predominance of isolates with the race 4 character. Although at present, the polygenic resistance appears to be effective against all races, it must be considered as a possibility that new races also may arise capable of destroying varieties with high levels of this type of resistance.

The recent discovery that sexual or compatibility mating groups exist in *P. infestans* in Mexico raises the question of the possible origin of new races through genetic recombinations. The possibility of the sexual or oospore stage as means of survival also must be considered. At present, only one of the mating groups has been found in isolates from the United States and Canada, whereas both groups have been found in Mexican isolates. Further work is necessary to determine if the sexual stage is a factor in race development and survival in Mexico. Also, with the knowledge that mating groups exist, a further search must be made in the United States and Canada to determine definitely whether both groups occur in any area in these countries.

Even though potato breeders recognize the complicating factors discussed above, they are going ahead with programs of breeding for resistance to late blight with some success. The goal of some is to develop a commercial variety having all the known dominant genes plus a high level of polygenic or field resistance. Large seedling populations are being screened each year with selected physiologic races to sort out the dominant genes. A good greenhouse technique of selecting for polygenic resistance has been developed, although attempts are being made to work out such a method. In the past few years, with cooperation from committee member J. S. Niederhauser of The Rockefeller Foundation in Mexico, many potato

breeders have submitted selections for field tests in Mexico. At present, this approach appears to be the most successful method of determining the degree of polygenic resistance in a selection. The committee wishes to express appreciation to The Rockefeller Foundation for their cooperation and recommends that testing of breeding material in Mexico be continued.

Ted Still and C. L. Fitch receiving certificates from President Cecil Frutchey signifying their selection for Honorary Life Membership in the Potato Association of America at annual meeting December 6, 1956. Prof. James G. Milward and Kris P. Bemis who were also honored could not attend.

TED STILL, HONORED

It is a double privilege tonight for me to be here, one to act as master of ceremonies and the other to have the pleasure of sponsoring Ted Still of Colorado as an honorary member of the Potato Association of America. Few deserve the honor more than he does.

Ted was born in Kansas, December 26, 1901. He grew up there, on a farm, and attended Kansas State College. For a time following graduation he worked for the state of Kansas as a wheat inspector. This occupation, testing wheat for protein content, amid the dust of grinding and the chemical fumes of the laboratory, caused him to contact vocational tuberculosis. Fighting this disease he migrated to Colorado finding his way into the San Luis Valley. This was Colorado's good fortune. Perhaps it was nearly an even exchange, since Colorado gave him his health back completely, and he gave Colorado one of the best foundation seed growers in the country.

He married in Colorado and has a family of four: his lovely wife Dorothy; his daughter Carolyn; and his son Douglas. They live on a potato farm near Monte Vista, Colorado.

Ted started raising potatoes in 1930 and began growing foundation seed in 1933. Later in the thirties when bacterial ring rot was in its first rampage he was largely responsible for saving the Red McClure industry. Many of you remember those times. The disease was new, we didn't know what it was. Before anyone became aware of its seriousness all varieties were contaminated. The Red McClure was no exception. Some one had to move quickly to prevent the extinction of the variety. Ted hand-picked hills and tubers showing no symptoms of the disease, cut the stem end of each tuber for a closer examination, and then tuber-indexed them under isolation being careful to avoid any contamination. He worked with this seed until it was disease-free, releasing some of it to his neighbors as it was increased. Today, twenty years later, ring rot disease has not been found on his farm. That seed was the beginning of the Red McClure industry that exists today. With few exceptions every field of Red McClure potatoes grown in the San Luis Valley came from that seed Ted nursed so faithfully at that time.

Ted adopted and originated other improvement practices early in his farming career. Not being content with good farm and marketing practices for himself he began thinking of his neighbors, his community, the San Luis Valley, the potato industry. One of the first things he did was to organize the San Luis Valley Potato Improvement Association. Organized solely for the improvement it could bring to the potato industry, it has never attempted to carry on any business. At its inception his neighbors elected Ted president and he has remained president to this day. It was the Potato Improvement Association with Ted carrying the ball, which helped instigate one of the first marketing agreement laws. Colorado has had a marketing agreement law for seventeen years. Colorado was also one of the first states to start compulsory inspection and to adopt the branding law. The San Luis Valley Potato Improvement Association was behind both of these movements.

In addition, Ted has always been an enthusiastic cooperator in Extension Service programs, community planning, and farm cooperative marketing. He has also been a leader and strong supporter of research. Not willing to wait for the natural sequence of activities to bring research findings, he helped originate needed research. He has served as research advisor to the Experiment Station for many years. The Improvement Association, with his guiding hand, early rented a farm to facilitate potato research. Later it purchased the farm and when it was paid for, donated the farm and facilities to the Agricultural College for research purposes.

Almost since the first day he grew potatoes he has been an official in the Colorado Certified Potato Growers Association. He has been president of this organization several different years. This is the agency which is the cooperating partner with the Agricultural College for the Certification of seed potatoes in Colorado.

Several years ago Ted received the Skelly agricultural award for his good farming practices and his foundation seed production. He was also one of the early Master Seedsmen of Colorado. This is an award that every seed grower in Colorado would give his right arm to possess. Ted was one of the first to receive this distinction.

In closing let me quote a paragraph written to me by one of his colleagues. "Ted has worked tirelessly to improve marketing conditions, too, not only in Colorado, but nationally as well. In the fall of 1953 when potato prices were at disastrously low levels he began to promote the idea of farmers solving their own marketing problems through marketing associations and marketing quotas, and to steer away from the idea of government subsidies. He has travelled thousands of miles, many of them at his own expense, to foster these ideas of self-help for the potato grower, and also single handed at times was able to get others to listen and give some thought to this phase of the potato industry. He is a member of the National Potato Council, constantly active in attempting to give aid to the national program."

It is with great pleasure that I sponsor Ted Still of Monte Vista, Colorado as honorary life member in the Potato Association of America.

CECIL FRUTCHEY, *Colorado A&M College, Ft. Collins, Colorado*

PROF. C. L. FITCH, HONORED

I consider it indeed a pleasure to be given the opportunity to sponsor my good friend of long standing, Prof. C. L. Fitch, for Honorary and Life Membership in the Potato Association of America. There are few persons on this continent who have done so much with so little public recognition as has Prof. Fitch. He is and has been for many years a man of action, a man who believes in getting things done, a man who has looked for little commendations for his many deeds—but one who has considered Providence very good to him by the pleasure he gets from seeing a job well done. Enthusiasm, integrity, truth, honesty, fairplay, vigilance, crusading and merit are words which describe the work of Profesor Fitch. I have indeed never known him to be accused of apple polishing or boot licking. Indeed, to the contrary, he has often taken pleasure in leading with his chin when he was firmly convinced that that was the proper technique to get his point across or to get his requested appropriation granted.

And speaking of appropriations I can truthfully say that we have with us this evening the man who is an expert at softening and mesmerizing budget directors and appropriation committees whether they be Federal, State or Local. I know this first hand from two personal experiences in connection with the United States House Agricultural Appropriations Committee hearings with reference to appropriations for the National Potato and Onion Committee. Following one of these hearings a Congressional Committeeman concluded the meeting by saying "I always consider very seriously the requests made by Prof. Fitch at these hearings since it has been my experience that great returns have resulted in the past from the appropriations which he has requested".

I am sure it is no secret to many of you that Prof. Fitch, more than anyone else, is responsible for the existence of the National Potato and Onion Committee and for the appropriations it has received since 1929 for potato breeding and since 1938 for onion breeding research. It has not always been easy—it has frequently been a thankless job. But I would not be describing Prof. Fitch if I told you he was looking for the easy way out unless it also hapened to be the one he considered best.

He has been for many years Secretary and Treasurer of the Iowa

State Vegetable Growers' Association and is still most active in that position. He is the man behind the guns at the fast moving, widely known annual meeting of this Association held at Mason City, Iowa. These meetings are scheduled for next Monday and Tuesday and I know that it was a sacrifice of time on his part to be in attendance here tonight.

He has been active for many years in the Vegetable Growers' Association of America and just last week was awarded their highest honor "The Vegetable Man of the Year". For 47 years he has been a correspondent of *The Packer* and thousands of persons look forward to reading his column in each issue of this publication.

He has sponsored a number of educational trips into various potato and vegetable growing areas of the country for the enlightenment and pleasure of his Iowa growers. No one has ever seen so much for so little in so short a time unless they have been on one of these tours. I greatly enjoy reading his periodic news letters which describe very vividly his activities in behalf of the state organization but also an occasional scolding of one or more of his growers for doing something which has not met with his approval. From these news letters I also get the feeling that I am privileged to look behind the curtain in his most happy home and see gracious examples of love, reverence and faith.

I have known Prof. Fitch since 1923 when I arrived at Iowa State College to begin my graduate work. Most of what I have said tonight has occurred since that first meeting. I know you will be interested in a brief summary of his earlier life and accomplishments. Prof. Fitch is 83 years *young* and if you think I have used the wrong word here, I defy you to keep up with him. He was born in Charles City, Iowa, March 29, 1873. On June 23, 1926 he married Miss Grace Dewey and they have three children, Dewey, David James and Faith Joan and a number of grandchildren.

Just to show you how versatile Prof. Fitch is, I will say that he was a dairy farmer and creamery superintendent from 1893 to 1903; a potato and sugar beet grower at Greeley, Colorado, 1903 to 1909; potato specialist at the Colorado Agricultural Experiment Station, 1909 to 1913 and Extension Vegetable Specialist at Iowa State College from 1913 to his retirement in 1946. Following World War I he was a member of the Educational Corps, A.E.F. and was an instructor in vegetables at Allery, France. He studied vegetable production in England, France, Italy and Germany. And let me dispel any idea that some of you may have that he is an expert only on potatoes and vegetables by telling you that he is the author of a publication with the intriguing title of "Some Women of France".

It is folly for me to try to enumerate all the many interesting and worthwhile activities and accomplishments of our guest this evening because of his long and extremely active period of years. Let me just say in conclusion that we of the Potato Association of America collectively and individually consider it a great honor and a privelege to have you with with us this evening, Prof. Fitch, and to have you accept from us our kindest thoughts and sentiments which are presented to you in the form of an Honorary Recognition as Life Member of this Association.

ORA SMITH, *Cornell University, Ithaca, New York*

PROF. JAMES G. MILWARD, HONORED

When our Vice President, Dr. R. W. Hougas asked me to present my old friend and associate, Professor James G. Milward, as a candidate for Honorary Life Membership in the Potato Association of America, I was very pleased. Jim's many friends throughout the industry will be glad to know that he is enjoying good health and this winter, he and his wife plan to drive to California to visit with members of their family.

James G. Milward was born on April 5, 1881 at Madison, Wisconsin. He graduated from the College of Agriculture of the University of Wisconsin in 1907 and was granted the M.S. degree in horticulture in 1909. He became interested in the potato plant as a young student and submitted a graduate thesis on early blight of potatoes. From 1903 to 1907 he was a part-time assistant in horticulture. Professor Milward became a full-time member of the Horticultural Department at the University of Wisconsin in 1907, and assumed leadership in the improvement of seed potatoes in the United States. He retired from active service at the age of 70 in 1951.

His early studies of varieties in the field dealing with problems of potato degeneration (virus diseases), varietal classification and adaptation served as a basis for later extension activities conducted cooperatively with the United States Department of Agriculture and other organizations. He emphasized the need for developing seed stocks by carefully selecting typical and productive hills and maintaining this seed separately for continued selection. By following these procedures, he clearly demonstrated that healthy vigorous seed, free from varietal mixtures, could be obtained. Professor Milward recognized the need to stimulate grower interest and understanding in the production of quality seed potatoes. Through his efforts the Wisconsin Potato Growers' Association was organized in 1912. One of its main objectives was the development and distribution of quality seed on a community, state and national basis .It is generally agreed that this early work in Wisconsin was of tremendous importance in getting organized potato seed certification underway in the United States.

Under a plan directed by William Stuart, and in cooperation with Dr. W. A. Orton, Professor Milward was appointed Field Representative of the USDA to supervise the planting, harvesting and evaluation of seed potato plots in Southern areas — mainly Louisiana, Texas, Alabama, Oklahoma and Arkansas. One object of this work was to bring about desirable relations between Northern producers and Southern consumers of seed.

The USDA in 1917 arranged for J. G. Milward to work with Station leaders and growers to promote seed potato certification and to increase seed potato supplies for war-time emergency. A series of meetings were held in Nebraska, North Dakota, Montana, Minnesota, Colorado, Utah and Oregon to aid in accomplishing these objectives.

Milward was an active member of the Potato Association of America during its early formative years. He served on various committees, especially seed certification committees, and was President of the Association at its Boston, Massachusetts meeting in 1922.

G. H. RIEMAN, *University of Wisconsin, Madison, Wis.*

KRIS P. BEMIS, HONORED

Kris, as he is generally known, was brought up on a farm in Michigan and graduated in horticulture from Michigan State College in 1915. He studied marketing under Dr. H. J. Eustace, who was about the only instructor in the field of marketing at that time.

After graduating, he went into county agent work in Brooke County, West Virginia. He left there to return to his home state and become County Agent of Mason County, Michigan. From there, he joined the Michigan Potato Growers Exchange and stimulated the production of certified seed potatoes in Michigan. He devised many of the rules and regulations for seed certification and set up a marketing plan for Michigan certified seed. He then joined Albert Miller and Company of Chicago, Illinois, where he handled the sale of certified seed potatoes, select seed and some table stock. Again he stimulated the production of certified seed in a very wide area to become Branch Manager for their production department in the Lake in the North Central states. From there he went with the Brown Company Okeechobee area of Florida. Here he arranged for the harvesting, packaging, and distribution of many vegetable crops.

He joined the Agricultural Adjustment Administration, handling marketing agreements primarily on potatoes and was instrumental in helping establish many of them. He always advocated the packaging of a better product. He then went with the Cleveland Tractor Company as a District Sales Manager. From there he went back with the Agricultural Adjustment Administration to become the Regional Director of the Food Stamp Plan, with headquarters at Philadelphia, Pennsylvania. He then transferred to the Office of Price Administration, handling the food rationing for institutional eating places and helped guide them with respect to obtaining vegetables and potatoes for their menus. When he left, the Pennsylvania Restaurant Association gave him a testimonial dinner for the outstanding services that he rendered. He left the Office of Price Administration to become Secretary of the Potato Division of the United Fresh Fruit and Vegetable Association, which position he currently holds. His efforts to promote the consumption and improve the marketing of white potatoes have been outstanding. The publication "*Spud Light*" which Kris writes keeps the trade well informed.

He stimulated and was practically the founder of the Utilization Conferences. He always has been interested in research and stimulated research not only in the field of potatoes but in many other projects.

He is married and has two grown children, a son and daughter, both of whom are married. He has a fine woodworking laboratory, which is one of his hobbies. The other hobby is working with the Boy Scouts of America. He is Vice-Chairman of the Prince George's District of this organization. He has spent considerable time during the summer with the boys camping in the woods but, of late, has not had much opportunity for this, but he usually can combine this hobby with the work of the Boy Scouts Troop No. 228.

He always has been interested in the farmers' welfare and in the potato industry in general.

A. E. MERCKER, *National Potato Council, Washington, D. C.*

1957 ANNUAL MEETING

The vote on the location of the annual meeting of the Potato Association of America was in favor of the Plant Industry Station, U.S.D.A., Beltsville, Maryland on December 2, 3, and 4. A request for titles of papers will be published later.

BOOK REVIEW

Walker, J. C. 1957. Plant Pathology. Second Edition. McGraw-Hill Book Company, Inc., New York. 707 p. Price $10.00

The second edition of Dr. Walker's textbook designed for an elementary course in plant pathology, follows the organization used in the first edition. Up-dating the information given in the previous edition constitutes the major changes. Terminology, classification and economic importance of plant diseases, and the history of the science are adequately covered in the first two chapters. Non-parasitic diseases and diseases incited by bacteria, phycomycetes, fungi imperfecti, ascomycetes, basidiomycetes, phanerogams, nemotodes and viruses are well treated in succeeding chapters. The symptoms, the causal agents, the disease cycles and control measures for over 100 well selected diseases on a wide variety of crops are discussed. Chapters dealing with general topics such as the relation of the environment to disease, host-parasite interactions, and disease control through exculsion, eradication, protection and disease resistance emphasize the basic principles of plant pathology. References following the discussions on specific diseases and general topics include the most important papers published. The book is well illustrated. This is by far the best textbook, for the beginning student, in the field.

B. H. DAVIS, *Plant Pathologist, Rutgers University, New Brunswick, N. J.*

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FOOD TECHNOLOGIST SPECIALIZING IN POTATO PROCESSING

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Present position, assistant manager of large potato starch and instant potato factory. Looking for similar position in which my background can be used beneficially.

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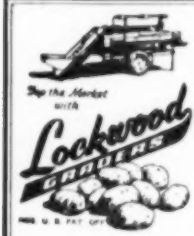

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W. J. DICKSON, Dickson Bros., Gilby, North Dakota

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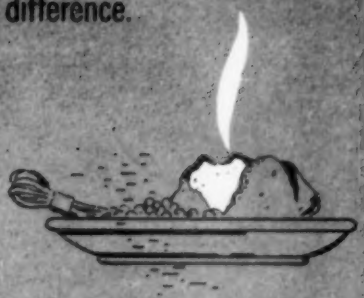

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